Social Radar

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ABSTRACT

Events like the so-called "Arab Spring" underline the need for the United States and its allies to reliably monitor the global information environment, so that they can build sociocultural understanding, anticipate change before it happens, and plan for appropriate action regarding adversaries and general populations. Today's diplomats, developers, and defenders require an integrated set of capabilities that we refer to as a "social radar." Such a system would support strategic- to operational-level situation awareness, alerting, course of action analysis, and measures of effectiveness for each action undertaken. Success of a social radar depends on continuous access to global data on perceptions, attitudes, opinions, sentiments, and behaviors. Much of the most timely and valuable data will be found in social media applications such as Facebook, Twitter, Flickr, YouTube, and various blogs. In this paper we discuss current approaches and prototypes that implement capabilities in the area of multi-data type processing and analysis, describe remaining shortfalls, and propose ways ahead for research and integration. Based on what we have learned through our involvement with research and transition projects in this domain, we believe that current and planned prototypes of a social radar may allow users to understand the cultural environment, achieve more complete situation awareness, and model alternative courses of action that the United States and its allies could employ to meet a variety of challenges. Further, these prototypes can address the challenges of using social media and other data to support timely understanding and effective dialogue, provide warning, demonstrate the effectiveness of social media proxy polling as a potential substitute for traditional polling, determine and monitor group sentiment across the globe, model the effectiveness of our proposed engagements, and measure the effects of such engagement in designated situations.

1.0 INTRODUCTION – THE NEED FOR 21ST CENTURY SENSORS

In the 20th century, advances in radar, sonar, and infrared sensing dramatically improved our ability to perceive physical objects through air, water, and darkness or camouflage. In the 21st century, the strategic center of gravity has shifted. National leaders increasingly emphasize the importance of cultural understanding and engagement not only with allied and adversary governments, but also with the populace, as critical determinants of our strategic success or failure. U.S. Department of Defense (DoD) thought leaders, doctrine, and planning increasingly focus on the importance of human geography, human terrain, and sociocultural analysis and modelling. Today's diplomats, developers, and defenders need integrated capabilities that will provide insight into the attitudes, perceptions, and intentions of citizens and leaders around the world.

At present, the United States and its allies and partners, including NATO, would benefit from having greater capacity to understand, track, anticipate the effects of, or react effectively to the kinds of communication that

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feed large scale uprisings, or to understand and exploit the relationship between non-kinetic messaging and nation-state stability. Furthermore, future conflicts may not take place in a clearly bounded physical battlespace, may not involve national militaries, and governments may have only minutes to hours to react to emerging events. The lines between physical and cyber, kinetic and non-kinetic, have blurred. In response, whole-of-government/comprehensive approaches are increasing. For example, the rebellion in Libya, arguably facilitated by social media, led to Operation Unified Protector, which included U.S.-led strikes on air defenses and other targets in Libya, and eventually handoff of the air strike mission to NATO.

Conventional Intelligence, Surveillance and Reconnaisance (ISR) and Indications and Warnings (I&W) methods and tools were designed to detect physical objects and movements. Alone, they cannot provide indications prior to an insurrection, insight into how extremist rhetoric may be radicalizing youth around the world, knowledge about emerging popular movements, or the ability to forecast the next "Arab Spring," wherever it may be. We need a 21st century ISR that can provide "tripwires" to inform analysts about rapidly emerging situations and allow for the development and exploration of courses of action.

Recent events suggest the great potential of social media as an important input for this 21st century ISR, especially when combined with other data sources. Social media have become an increasingly important mechanism for conducting personal, business, and governmental communications. Facebook, YouTube, Twitter, and other leading tools have become standard elements of the communication strategies and tactics of individuals, groups, organizations, and nations. Much has been alleged about the impact of these tools on behavior, as in the North African uprisings sometimes referred to as the "Arab Spring." The factors that drive national-scale change do not arise overnight, nor are they caused by Facebook or other social media applications. Yet it seems that the structure and content of large-scale communication can significantly shape events in the months or years preceding social unrest, as that unrest unfolds, and in its aftermath. Such communication also appears to play a very important part in building the networks that enable violent extremism, developing the strategies, tactics, and actions of violent extremist organizations, and determining the impact they have on adversaries and general populations. Traditional sensors, supplemented by current and emerging technologies that can detect expression of sentiment in open source and social media data, can enable analysts to identify breakpoints that signal major sentiment shifts likely to have effects on the behavior of populations or governments.

Figure 1: Illustrations of social media in national unrest

Figure 1: 21st century ISR will use new and proven sensors

2.0 GOVERNMENT INITIATIVES

In response to the rapidly evolving geopolitical information environment, the defense, development, and diplomatic communities are increasing emphasis on sociocultural understanding and effective communication. Different communities use terms such as strategic communication, information operations (IO), Military Information Support to Operations (MISO), public diplomacy, and smart power to describe initiatives with the same core goals: to understand the current human environment, engage the right audience with the right message, and then measure the effects of the messages.

Figure 2: Recent events underline the need for smart power

Recent changes in the Department of State's organization and standard practices mirror changes in the dynamics of the world's geopolitical communication. Secretary Clinton began her tenure by stressing the need to elevate civilian power alongside military power as an equal pillar of U.S. foreign policy. She called for an integrated "smart power" approach to solving global problems—a concept embodied in the President's National Security Strategy and now in the Department of State's first Quadrennial Diplomacy and Development Review (QDDR) [1]. Furthermore, the department's Bureau of International Information Programs (IIP) will shift to more proactive tactics and will expand use of mobile technologies, including Short Message Service (SMS) programs and smartphone applications, while ensuring the continued provision of products for such traditional media as print and radio. Supported by a central translation team, IIP will also provide more products in foreign languages, consolidate content production, and develop a new audience research unit intended to provide research and analysis on audiences, channels, and use of IIP products. Further, the department will expand the Digital Outreach Team, which engages the (non-U.S.) public on social media sites.

The 2010 Quadrennial Defense Review (QDR) [2], which sets long-term priorities for the DoD, stresses that to succeed in counterinsurgency, stability, and counterterrorism operations the United States must build the competence and capacity of general purpose forces and strengthen key supporting capabilities for strategic communication. In his 2011 memorandum on Strategic Communication and Information Operations, [3] U.S. Defense Secretary Gates wrote:

[T]he President has heightened U.S. Government strategic emphasis on countering violent extremism through effective strategic communication and IO (the latter now defined as the integrated employment, during military operations, of information-related capabilities in concert with other lines of operation to influence, disrupt, corrupt or usurp the decision-making of adversaries and potential adversaries while protecting our own).

The DoD research and engineering (R&E) community is supporting these evolving national priorities, in part by leaning forward to conduct sociocultural behavior research, develop resources and tools, and transition them to users. In January 2011, the Office of the Secretary of Defense (OSD) Human Social Culture Behavior (HSCB) Modeling Program convened Focus 2011, an international conference attended by over 600 individuals from academia, industry, and government. In separate addresses, the Principal Deputy Assistant Secretary of Defense Research and Engineering (ASD (R&E)), and the Deputy Chief of Naval Research for Expeditionary Maneuver Warfare and Combating Terrorism issued challenges to move fast and provide useful capabilities to warfighters. Major General Michael Flynn, former Director of Intelligence for International Security Assistance Forces in Afghanistan, echoed this message, challenging the attendees to take risks, incorporate emerging technologies into their programs, and enable rapid deployment of new capabilities. The nation's legislative branch is also taking notice: the House Armed Services Committee and Senate Armed Services Committee have urged ASD (R&E) to coordinate technology development across the department, understand user needs, and transition technology both to help users in need and make a difference.

A recent DoD publication, *Sociocultural Behavior Research and Engineering in the Department of Defense Context*,[4] establishes a vision for building the Department's sociocultural behavior capability. The Foreword includes this statement:

Success requires being able to anticipate how factors such as culture, society, group identity, religion, and ideology influence the behavior of foes and others in foreign populations. This new reality demands a broader, deeper capability, realized at tactical, operational, and strategic levels, and founded on the social and behavioral sciences.

To ensure that R&E investments reflect the U.S. military's strategic priorities and leading operational challenges, the document calls for building warfighter capabilities to **Understand** sociocultural behavior, **Detect** relevant sociocultural signals, **Forecast** events through persistent sensing of the environment, and **Mitigate** impacts with measurable courses of action grounded in the social and behavioral sciences. *Sociocultural Behavior Research…* highlights the considerable success of DoD sociocultural behavior R&E, and indicates a number of areas where further work would best build on that strong foundation (see Figure 5). Those areas are distilled to ten core recommendations, which include "research and engineer a social radar—a global and persistent indications and warnings capability consisting of integrated technologies for detecting and monitoring operationally relevant sociocultural behavior signatures."
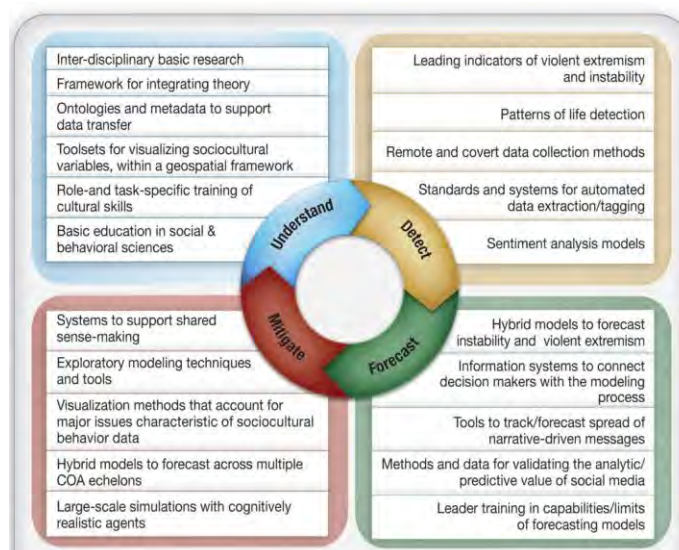

Figure 4: Sociocultural behavior capability areas and research thrusts

3.0 THE VISION FOR SOCIAL RADAR

Emerging social radar technologies that allow us to monitor, model, and predict the emergence of national or subnational instability, the spread of violent extremism, deceptive practices in cyberspace, or other activities must be combined to create a comprehensive operating picture. In his 2010 paper defining social radar, [5] Dr. Mark Maybury stated that:

> *The center of gravity in modern warfare not only includes military targets such as tanks, ships, planes, command and control facilities, and military forces but equally important the perceptions, intentions and behaviors of citizens and leaders. While radar, sonar, and infrared vision serve our military forces well, they provide limited insight into the social, cultural and behavioral activities of populations. While hard power will always play a key role in warfare, increasingly soft power (Nye 2004), the ability to not coerce but to encourage or motivate behavior, will be necessary in the future of our increasingly connected and concentrated global village....A Social Radar needs to sense perceptions, attitudes, beliefs and behaviors (via indicators and correlation with other factors) and geographically and/or socially localize and track these to support the smart engagement of foreign populations and the assessment and replanning of efforts based on indicator progression.", and that a social radar "needs signatures, calibration, and correlation to sense, if not forecast, a broad spectrum of phenomena (e.g., political, economic, social, environmental, health) and potentially forecast changing trends in population perceptions and behaviors.*
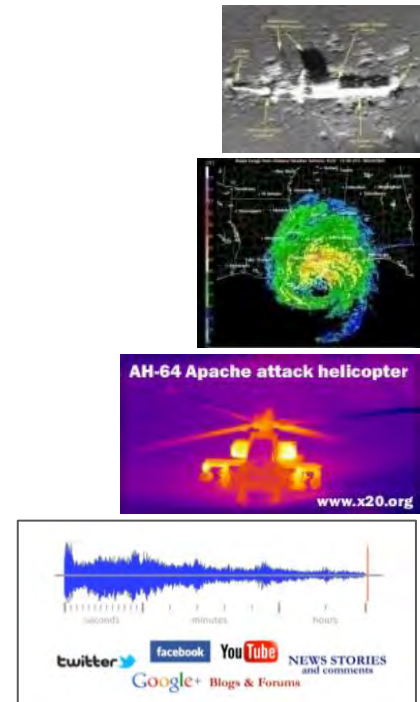

Figure 5: Sonar, radar, infrared, social radar

To be most effective, a social radar should take a data-to-decision support perspective, allowing analysts to tailor and weight the fusion of indicators, draw on online sources to update model parameters, and use course of action models to provide quantitative evidence for indicator integration strategies. Realizing this vision will require an analysis environment that supports the development of common output measures, management of uncertainty analyses, and model validation. Ultimately, such an environment will allow analysts to explore data, perform diverse analyses, generate products for decision makers, and help communicate findings through tailored dashboards that support drilldown and knowledge management.

Success of a social radar depends on continuous access to global data on general population perceptions, attitudes, opinions, sentiments, and behaviors. Much of the most timely and valuable data will be found through a variety of increasingly Internet-based sources, including, of course, social media. Analysts must use <u>all</u> relevant data, in conjunction with current and emerging technologies, to support an analysis of non-kinetic messaging, forecasting of messaging effects, course of action planning, and measurement of effects. This combination of data and technical capabilities will enable improved situation awareness and decision support for anticipating instability, countering violent extremism, and building partner capacity.

Reaching this end state will require researchers and developers to address a number of fundamental

questions:

- Using mobile devices and crowd sourcing as input mechanisms and data, how can we rapidly collect and process relevant social media and Internet data?
- How can we process data at a global scale, while maintaining responsiveness and system stability?
- How can we rapidly determine opinion and sentiment?
- How does social media content correlate to future events? Can we show causation?
- How can we use all data types and resulting analysis to perform resource allocation?
- How can we detect and gauge the spread of groups, networks, messages of interest, and sentiment (especially regarding strategic adversaries and extremist organizations) in time and space?
- How can we extend present thresholds of precision and recall to ensure that false positives remain at an acceptable level?

Using social media as a source of data for a social radar presents various challenges. One general challenge stems from the enormous variations in information structure, which makes it difficult to integrate across data streams. The current ability to extract information on low- and high-level entities, groups, and networks from unstructured text is very uneven. Beyond these comparatively straightforward language processing tasks lies the difficulty of detecting and attributing sentiments, and of understanding the links between sentiment, motivation, and behaviors. Many analysts who support ISR and I&W have become increasingly interested in sentiment analysis, but the technology to support this capability remains very much in the early stages of readiness.

A very important, but primarily non-technical challenge is privacy. Recent coverage of U.S. Department of Homeland Security (DHS) programs on social media highlights concerns in this area.[6] The DoD takes this issue very seriously and ensures that its sponsored research and engineering adheres to the many laws, regulations, and guidance documents defining what can and cannot be collected in a broad spectrum of possible situations. Research described in this paper relies solely on open source material that is in the public domain.

4.0 ENGINEERING A SOCIAL RADAR

Clearly, fully achieving the capabilities described in Dr. Maybury's defining paper and the *Sociocultural Behavior Research* report will require long-term research and development. However, more limited, but still useful, objectives can be attained in the short term, including the development of operational prototypes that demonstrate a social radar capability. Midway through FY11, work began on a social radar prototype that would instantiate these guiding visions and documents in software prototypes and demonstrate a modular enterprise-level system that will give analysts access to representative data in near-real time and tools that support alerts. The goal is to create an environment that allows analysts to explore data, perform diverse analyses (using tools, models, and forecasts), generate products for decision makers, and help communicate analyses through customized dashboards.

Figure 3: Concept for a social radar

4.1   Drivers

A social radar will exploit data from open sources, including social media, to help analysts understand what is happening on the ground. Because a social radar must operate within different user architectures and environments, the developers are taking an overarching enterprise approach and building the capability as an enterprise-focused testbed for early transition of sociocultural tools. The prototype will accommodate emerging technologies and support strategic- to operational-level situational awareness, alerting, and course of action analysis.

To achieve a proof of concept for this vision, the developers must address a number of questions:
- What architectures should be used?
- What data strategies can be used to populate it?
- What visualization strategies (dashboards) are needed for data/indicators/results?
- What are the strategies for appropriate, rigorous use of tools, and series of tools?
- What capabilities are needed at what echelons and across mission spaces?
- What sustainment strategies should be implemented?

For U.S. and coalition forces to adopt social radar and use it appropriately, the system must be both useful and simple. It is important in any prototype development to focus on identifying common analytic tasks and planning more broadly for indicator integration. To that end, developers are engaging end users in the various armed services, and in the diplomatic, development, and intelligence communities. Understanding the existing analytic workflow requires a deep understanding of the analytic task and mission. Once tasks and missions are understood the developers can adapt the Social Radar prototype to support analyst workflows—especially rigorous, easy-to-use methodologies that depend on these advanced capabilities.

The Social Radar prototype currently incorporates four examples of different approaches to indicator integration. A next step will be to use indicators in models for evaluating courses of action. The prototype can also collect data on system use (searches done, tools used, tools used together, products created). And, of course, the Social Radar must be continuously refined to improve the analyst experience, potentially through the use of an evaluation widget.

As we have noted, social radar is an ambitious vision that can only be realized fully over the long term. However, from the beginning research and engineering have proceeded with transition to the DoD enterprise in mind. Specifically, emphasis has been placed on composability, and building to the Ozone Widget Framework (OWF). Among the specific, near-term steps being taken are the following:

- Work with the US Army customers [7] to identify options for instantiating Social Radar tools on its unclassified network cloud
- Develop Social Radar into a test and evaluation environment for transition
- Test evaluation methodologies on tools brought into the evaluation environment
- Focus on use cases

4.2   Achievements

In six months, progress has been made toward each of the goals below, particularly on the highest priorities of integrating research and development projects and demonstrating a social radar vision.
1. Integration of what had been discrete research efforts
2. Working with data at scale
3. Development of a cohesive interface to transition technology into workflow-based capabilities
4. Development of Ozone-based capabilities
5. Development of an integrating "model" that aggregates individual capability outputs into a predictive analytic capability
6. Demonstration of a useful, mission-focused, end-to-end social radar

Many organizations are performing outstanding technical work in this domain. Research and development of a Social Radar prototype has been guided by these principles:
- Integrating and, when necessary, developing a technology solution that provides a unified vision for DoD users
- Exploring key issues and technologies associated with the establishment of end-to-end prototypes in this data rich domain
- Incorporating a wide geographic focus on instability
- Constructing an unrestricted data domain consisting of open source English and foreign language data of varying types, including social media
- Engineering to process and analyse social media and other data at scale
- Building to DoD enterprise standards to ensure transition

An underlying architecture supports the use of the OWF, and enables incorporation of multiple capabilities at various levels of integration to support geospatial hot spotting and instability forecasting. Capabilities that are presently the object of research and development include:

- Sentiment analysis and topic discovery
- Ideology identification in multiple languages
- Emotion analysis of social media for instability monitoring

- Automated breakpoints for change detection from online sources
- Mapping influence via online postings
- Cluster analysis, ranking, and exploration for online postings
- Course of action analysis using nation-state simulation models

The topic discovery and sentiment analysis effort includes tools and techniques to support the definition, discovery, and tracking of sentiment-target constellations. Rhetoric usually focuses on particular issues, but bundles of these issues, grouped as sets of sentiment-target pairs, can capture broad viewpoints on key regional issues. Unsupervised learning is used to discover unexpected sentiment-target pairs and any associations that are "hot" – particularly significant in terms of their volume and degree of sentiment. Plans include development of techniques to automatically identify sentiment triples (Opinion Holder, Sentiment, Target of Sentiment) to support the development and discovery of strongly associated entity targets and/or opinion holders.

The revolutionary triggers project is identifying indicators that may lead to uprisings and could help accelerate events. The approach combines deep linguistic analysis and temporal modelling of topic and sentiment classification to forecast discontent and to measure the effects of U.S. policy. Modelling is performed not only in English, but also in select foreign languages.

A project on emotion analysis is developing and integrating a new approach to characterizing current and future moods among populations by combining a validated automated content analysis program, Linguistic Inquiry and Word Count (LIWC) [8], with a mathematical algorithm to automatically detect breakpoints (i.e. discontinuous change) in population moods. As a test, Twitter data were generated after a contested
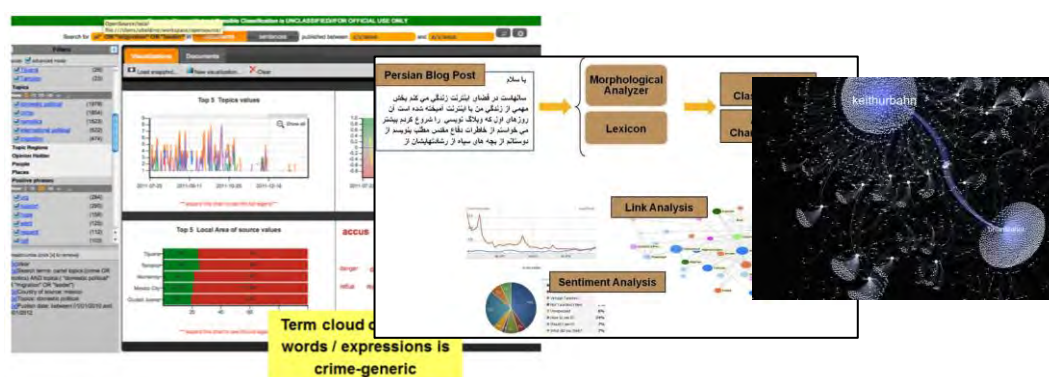

Figure 7: Snapshots from Social Radar analytic tools

presidential election. As reported in a separate paper, four mathematical prediction algorithms were statistically compared to determine which most accurately predicts public mood. The paper includes a real-world application of the best algorithm to show how, in practice, it could have clarified the direction of public mood at various points after the election.[9]

To enable influence mapping, trained statistical algorithms are being developed to determine how information spreads through social media. The algorithms make it possible to model the flow of information between postings on a blog or microblog to identify changes in patterns of information spread.

The Social Radar prototype also includes a cluster analysis tool that groups similar messages together, sorts comments by relevance, visualizes trends over time, identifies active users, and enables drilldown from high level concepts to the data behind the trends. The tool was designed to help analysts rapidly process large

volumes of blog comment threads, but has also been adapted for application to Twitter data.

Critical to the ultimate success of a social radar is supporting the exploration of alternative courses of action. Research is underway to experiment with ways to best integrate online sources, (including blogs and social media) into simulation models to assess courses of action. This work includes evaluation of three models: Political Instability Task Force (PITF) [10], System Dynamics Approach to Modeling and Understanding Stability (S3DM) [11], and The National Operational Environment Model (NOEM) [12]. Multiple data sources are being used to populate use cases for these models and compare courses of action to create a landscape of plausible futures. This work will make it possible to determine and track data used in models, run course of action models from a widget with various parameters and options, and display the model output in a visualization widget that supports warfighter course of action analysis.

Usability of a social radar system is also a critical consideration. Therefore, as core data and analytic capabilities are pursued, research is also going forward on a dashboard user interface designed to support situational awareness and assist in decision making. The dashboard will include tools and methods to fuse and weight sociocultural indicators and other data sources as the need arises. A quantitative approach is being pursued to determine the impact of indicators on the situation and decision spaces. Work to date has included implementation of instability models at various levels, using traditional data sources to model stability globally and create a baseline visualization for instability hot spotting on the globe/map and layer others. Social media data/indicators, including link analysis, are being used to evaluate courses of action for the decision space (i.e., uncertainty analysis, common measures of effectiveness with multiple sub-metrics as inputs). Many of the data and services will be accessible via mobile applications (tablets) and web applications.
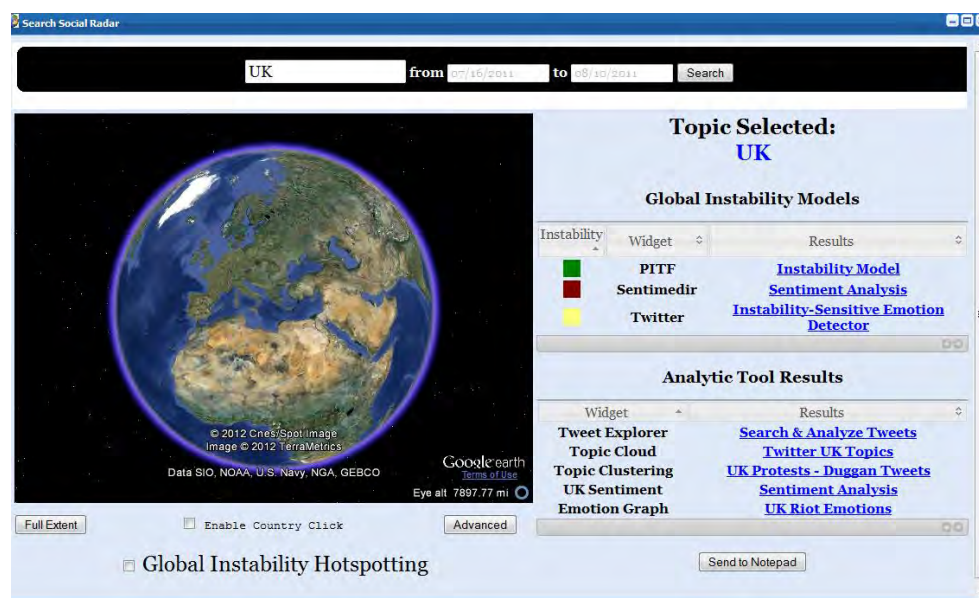

Figure 8: Snapshot of Social Radar prototype dashboard

5.0 CONCLUSION

While building a social radar remains a challenge, technologies exist to detect, monitor, and sometimes predict changes and instability events. Using a portfolio of projects and an integrating project, we have demonstrated the operational functionality of such a social radar for select use cases.[13] As work progresses, the Social Radar project team will address and document the challenges of creating an end-to-end system for searching data at scale, establishing composable data services, developing more analyst tools, visualizing data for analysts, and providing reporting capabilities.

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